

Economic study of groundwater irrigation system in Lampung Province

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Abstract. The utilization of groundwater for irrigation purposes in Indonesia, known as Jaringan Irigasi Air Tanah (JIAT), has been developed since 1970 and nowadays they can be found in nearly all region in Indonesia. For example, in Lampung Province, there are 112 JIAT facilities under the authority of the Mesuji Sekampung River Basin Agency. One of the benefits of JIAT is its reliability as it warrants water availability all year long. On the other hand, JIAT operation is costly. Therefore, agricultural irrigation system such as JIAT is less attractive to most farmers unless there is some kind of government subsidy. This paper presents an economic study of JIAT by comparing the benefit for the farmers with the operation cost to determine the feasibility of a JIAT facility. This study is based on the inventory data of JIAT facilities in Lampung Province. The method used in this study is descriptive quantitative. The final result of this study is a recommendation for feasibility requirements for a JIAT facility as a whole, which can be used by River Basin Agencies (BWS/BBWS) in Indonesia as a guideline to determine the feasibility and sustainability of a JIAT facility.

1 Background

JIAT is an agricultural irrigation system, especially for areas not covered by surface irrigation. The purpose of JIAT development is to help the farmers increase harvest production capacity without constraining water availability.

JIAT has been developed since 1970 and nowadays they can be found in nearly all region in Indonesia. In Lampung Province, there are 112 (one hundred and twelve) JIAT facilities under the authority of the Mesuji Sekampung River Basin Agency (Balai Besar Wilayah Sungai Mesuji Sekampung = BBWS MS). In accordance to national regulations, the government is obliged to carry out development and also maintenance of the JIAT infrastructure. Whereas water-use farmers, it is advisable to finance their own operating costs after the first 2 years of infrastructure completion.

In fact, the existence of JIAT infrastructure does help to overcome water scarcity in the dry season, so farmers can still irrigate their fields by relying on water from JIAT. However, JIAT's operating costs are not cheap, ranging from fuel expenditures to wages for JIAT operators. This will be worsen if the infrastructure performance conditions are not good, so operating costs are higher and conversely the benefits received by farmers are lower.

The purpose of this study was to calculate the economic feasibility of JIAT from the side of farmers and government.

2 Location of study

Study locations are 112 JIAT spread in Lampung Province, there are 7 JIAT locations in Tulang Bawang, 5 locations in Way Kanan, 7 locations in East Lampung, 3 locations in Pringsewu, 31 locations in Central Lampung, 57 locations in South Lampung, and 2 locations in Pesawaran District.

3 Method

This study is based on the inventory data of JIAT facilities in Lampung Province. The method used in this study is descriptive quantitative, which comprises of several steps, i.e., conducting (1) collaborative efforts with BBWS MS on collecting updated data of JIAT in 112 locations, which consist of data on physical and functional conditions of JIAT infrastructures, crop productivities, personnel organizations, all documented information, and the Groundwater User Farmers Association; (2) analysis of JIAT performances based on available data and Government Regulation of Ministry of Public Works and Public Housing Regulation Number 12/RT/M2015

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regarding Exploitation and Maintenance of Irrigation System; (3) analysis of the actual cost for Operation and Maintenance (O & M) for each JIAT facility, namely AKNOP; (4) data collection of JIAT benefits for the farmers through questionnaire and interviews with the farmers; (5) economic analysis based on benefit and operation cost, so the economic feasibility of JIAT system in Lampung Province can be determined.

3.1. Inventory of secondary data

Secondary data are summarized in the technical tables. For example, Table 1 is show one data in SBP71, it is one of location of JIAT in Sidoreno, South Lampung.

Table 1. Technical data from SBP71, JIAT in South of Lampung.

No	Component	Information
1	JIAT Location	SBP 71
2	Province	Lampung
3	District	Lampung Selatan
4	Sub-District	Way Panji
5	Village	Sidoreno
7	Bench Mark Coordinate	48 M 564805 9381697
8	Control Point 1 Coordinate	48 M 564807 9381706
9	Control Point 2 Coordinate	48 M 564817 9381702
10	Year of Drilling	1999
12	Depth of JIAT	110 m
13	Position of Water Elevation	18,2 m
14	Diameter of well	22 cm
15	Type of pump	Submersible
16	Debit of pump	10 ltr/second
17	Driving machine	Diesel
18	Divider	23 unit
19	Size of divider	
	a. long	110 cm
	b. wide	110 cm
	c. hight	55 cm
20	Diameter of pipe	10
21	Dimention of Pump House	
	a. long	718 cm
	b. wide	315 cm
	c. hight	350 cm
22	Benefit	
	Household	None
	Irigation	56 family
23	Planting area	
	Secondary crops	13
	Rice	25
24	Planting period	
	Secondary crops	Sep – Des
	Rice	Des - Aprl, Juni – Sep
25	Produktivty	14 ton/Ha/year of rice
31	OM funder	Farmer
32	Operator salary	Rp 750,000 per month

3.2. Performance assessment

Based on Ministry of Public Works and Public Housing Regulation Number 12/RT/M2015 about Exploitation and Maintenance of Irrigation System, it is stated that in order

to assess JIAT's operational and maintenance performance, the things that must be considered are the performance of physical infrastructure, performance of crop productivity, performance of JIAT supporting facilities, personnel organization performance, completeness of JIAT documentation, as well as the performance of Groundwater Users (P3AT).

Assessment of the performance of physical infrastructure is carried out on:

1. Well performance is assessed based on the physical condition and function of the well to produce water in accordance with the pumping test capacity.
2. Pump performance is measured based on the physical condition and function of the pump to pump water as needed in a year.
3. The performance of the drive engine is measured by the physical condition and the ability of the engine to drive the pump according to needs.
4. The performance of the pump house is measured by the physical condition and function of the building including its facilities.
5. Channel performance is measured based on physical conditions and the function of the channel to drain water as needed.
6. The performance of complementary buildings is measured based on the physical condition of the building with functions according to planning.

The second component is cropping productivity where the previous year's productivity is calculated. Cropping productivity is compared to the average productivity that occurs in certain areas. JIAT performance related to the components of planting productivity is assessed based on 5 (five) parameters, namely:

1. Level of water needs
2. Realization of planting area
3. The level of rice productivity
4. The level of productivity of crops
5. The harvest value is compared to the costs incurred by farmers for water supply

The third component is a supporting facility, it is the facilities that support the operation and maintenance JIAT system to become effectively and efficiently. Supporting facilities assessed in the JIAT performance assessment are:

1. The well is monitored, it is necessary to measure the ground water level at all times, so that the calculation of water availability can be determined with certainty.
2. OP equipment includes basic tools for routine maintenance and personnel equipment for the operation.
3. Transportation equipment for government officials who conduct guidance and supervision and operators
4. Office equipment for the observer's office and the executor of the OP in the field.
5. Communication tools for observers and operators.

The fourth component is the personnel organization, which is the implementing organization of the OP in each well that is fully formed with personnel composition along with their job descriptions and responsibilities. The number and quality of personnel must match the needs. The duties and responsibilities of the government in managing the JIAT should only be limited to guidance

and supervision. Therefore, the performance of the personnel organization is assessed based on the existence of the organization, the completeness of the organization, as well as the qualifications and competence of the personnel. The fifth component is the document, which consists of:

1. JIAT data book which includes technical and historical data from the JIAT development process.
2. Map of the situation of plots of land served, network schemes, and building drawings (as built drawings).
3. OP manual that has been adjusted to the last condition of the network.

The sixth component is P3AT. According to Ministry of Public Works and Public Housing Regulation Number 17/RT/M2015 concerning Irrigation Commission, what is meant by water user farmers are all farmers who benefit directly from water management and irrigation networks. Farmers in question include farmers who own rice fields, farmers who cultivate rice fields, rice paddies, fish pond owners, and business entities in agriculture that utilize irrigation water. Whereas P3AT is an irrigation management institution which is a container of water-using farmers in a service area / tertiary plot or village that is formed democratically by water-use farmers including local irrigation management institutions.

Assessment of P3AT performance, according to Ministry of Public Works and Public Housing Regulation Number 32/RT/M2015, covering: legal institutional status, institutional development conditions, institutional activities in supporting the smooth running of the OP, and institutional participation in the implementation and financing of OP. The assessment level given in the JIAT performance evaluation results refers to the level of the assessment contained in surface water irrigation. The weighting of the JIAT Performance Index Assessment is presented in the following Table:

Table 2. Components and levels of JIAT assessment

No	Assessment Component	Ideal Value
1	physical infrastructure	45
2	Planting productivity	15
3	Supporting infrastructure	10
4	Organization structure	10
5	Documentation	5
6	Farmer group	15
	Performance Indeks	100

The results of assessment classified by four index performance:

- 80 - 100: Very good performance
- 70 - 79: Good performance
- 55 - 69: Poor performance and need attention
- <55: Worst performance and need attention

3.3. Analysis of operation cost

Operating costs incurred by farmers are fuel, operator wages, and light maintenance. This data is obtained from community interviews. The government cost such as operating costs other than fuel and maintenance costs for JIAT infrastructure or commonly referred to as AKNOP. JIAT infrastructures maintained include propulsion engines, pumps, pump houses, channels and networks,

buildings for construction, flow measuring structures, riser pipes, road inspections, transportation equipment, and operation and maintenance equipment. Whereas activities that are operated by the government are making plans for distribution and provision of water and evaluation, monitoring and evaluation of operational activities, as well as fostering and empowering institutions and human resources.

3.4. Economic analysis

Economic analysis from the farmer side is useful to provide input for the government and farmers regarding the sustainability of the current policy where farmers bear JIAT operating costs. The analysis is carried out in the form of comparing the harvest value and costs incurred by farmers for the operation of the JIAT in one year.

Economic analysis from the government side is useful to provide an overview of the effectiveness of the development of JIAT. The analysis was carried out by comparing the AKNOP and the value of benefits received by farmers. Both of this analysis produce numbers of Benefit Cost Ratio (BCR).

4 Analysis results

This paper shows one of example for assessment proses until the complete result in SBP71 Sidoreno, South of Lampung.



Fig. 1. The documentations of JIAT SBP71 in Sidoreno, South of Lampung

The results of the SBP71 location performance assessment are shown in the following table.

Table 3. SBP71 assessment result

No	Assessment Component	Ideal Value	Factual Value of JIAT	Performance Indeks	Information
1	physical infrastructure	45	35.55	35.55 x 100% : 45 = 79	Good
2	Planting productivity	15	12.00	15 x 100% : 12 = 80	Very Good
3	Supporting infrastructure	10	7.50	7.5 x 100% : 10 = 75	Good
4	Organization structure	10	10.00	10 x 100% : 10 = 100	Very Good
5	Documentation	5	0.85	0.85 x 100% : 5 = 17	Worst performance and need attention
6	Farmer group	15	11.40	11.40 x 100% : 15 = 76	Good
	Performance Indeks	100	77.30	77.30 x 100% : 100 = 77.30	Good

From the performance appraisal above, the results of the SBP71 performance index were 77.30, which means that it is a good performance category.

The next step is to calculate operating and maintenance costs by government (AKNOP), where the final results of the SBP71 AKNOP are presented in the following table:

Table 4. AKNOP (cost of operation and maintenance by government)

No	OM Category	Total of OM Expenditure
1	Maintenance of physical infrastructure	185,971,687
2	Maintenance of supporting infrastructure	25,771,050
3	Operation	164,986,400
	Total OM Expenditure (AKNOP) of SBP71	376,729,137

From the results above, economic analysis is calculated for the government and farmers.

For the Government:

Operating and maintenance costs per year is Rp 376,729,000

Benefits received by farmers: Increase in production results due to the addition of the planting period. Before there was a JIAT, farmers only relied on one period of rice planting during the rainy season, but after there was a JIAT, farmers could apply the Rice-Rice-Palawija pattern. The BCR obtained is: 1.34

For Farmers:

The annual operating and maintenance costs incurred by 1 farmer are Rp 51,840,000

Farmer's income in one year is Rp 114,000,000.

The BCR obtained is: 2.22

This step is applied to all JIAT locations in Lampung Province. Recapitulation of results is shown in the table below. Some locations are in a very bad state because the JIAT infrastructures were totally gone, so it cannot asses or it is given a zero value (0 / -).

Table 5. Recapitulation of JIAT performance in Lampung Province.

No.	JIAT	Perfor mance Index	AKNOP	BCR Gov	BCR Farm
1	SBP 1	0	-	-	-
2	SBP 2	0	-	-	-

No.	JIAT	Perfor mance Index	AKNOP	BCR Gov	BCR Farm
3	SBP 3	0	-	-	-
4	SBP 6	0	-	-	-
5	SBP 7	0	-	-	-
6	SBP 8	0	-	-	-
7	SBP 11	0	-	-	-
8	SBP 12	0	-	-	-
9	SBP 15	0	-	-	-
10	SBP 18	0	-	-	-
11	SBP 19	0	-	-	-
12	SBP 20	0	-	-	-
13	SBP 21	0	-	-	-
14	SBP 27	0	-	-	-
15	SBP 29	0	-	-	-
16	SBP 31	0	-	-	-
17	SBP 33	0	-	-	-
18	SBP 34	0	-	-	-
19	SBP 35	0	-	-	-
20	SBP 38	0	-	-	-
21	SBP 51	0	-	-	-
22	SBP 52	0	-	-	-
23	SBP 53	0	-	-	-
24	SBP 54	0	-	-	-
25	SBP 55	0	-	-	-
26	SBP 56	0	-	-	-
27	SBP 57	0	-	-	-
28	SBP 58	0	-	-	-
29	SBP 59	0	-	-	-
30	SBP 60	0	-	-	-
31	SBP 61	0	-	-	-
2	SBP 62	0	-	-	-
33	SBP 63	0	-	-	-
34	SBP 64	0	-	-	-
35	SBP 72	0	-	-	-
36	SBP 75	0	-	-	-
37	SBP 33	0	-	-	-
38	SBP 94	0	-	-	-
39	SBP 104	0	-	-	-
40	SBP 5	0	-	-	-
41	SBP 111	0	-	-	-
42	SBP 26	0	-	-	-
43	PPS 1	0	-	-	-
44	SBP 13	0	-	-	-
45	SBP 24	0	-	-	-
46	PPS2	0	-	-	-
47	SBE 5P	52.30	381,956,533	1.34	1.86
48	SBE 23	37.53	353,094,913	1.34	1.34
49	SBP 10	51.33	349,389,223	1.34	1.86
50	SBP 65	37.13	331,648,863	1.35	1.34
51	SBP 67	51.73	309,831,063	1.35	1.86
52	SBP 74	36.30	304,886,293	1.35	1.34
53	SBP 76	32.70	299,941,523	1.35	1.34
54	SBP 78	51.25	339,763,263	1.35	1.86
55	SBP 82	57.05	330,144,663	1.35	1.86
56	SBP 86	47.75	330,144,663	1.35	1.55

No.	JIAT	Perfor mance Index	AKNOP	BCR Gov	BCR Farm
57	SBP 91	32.30	326,839,563	1.35	1.34
58	SBP 98	46.55	326,839,563	1.35	1.55
59	SBP 107	37.40	269,127,963	1.38	1.34
60	SBP 90	35.85	326,079,183	1.35	1.34
61	SBP 95	46.35	326,079,183	1.35	1.55
62	SBP 103	59.95	363,636,573	1.34	1.86
63	SBE 36	33.45	366,387,603	1.34	1.34
64	SBP 101	48.75	245,462,343	1.38	1.55
65	SBP 50	25.45	259,890,243	1.38	1.20
66	SBP 83	72.30	229,206,903	1.38	2.22
67	SBE 21	74.50	367,122,223	1.34	2.22
68	SBE 39	74.50	309,831,063	1.35	2.22
69	SBE 40	84.25	366,584,713	1.34	2.50
70	SBE 42	74.60	331,244,963	1.35	2.22
70	SBP 4	66.10	364,223,533	1.34	2.00
71	SBP 9	78.92	334,554,913	1.35	2.22
72	SBP 16P	75.85	319,720,603	1.35	2.22
73	SBP 23	85.65	322,030,263	1.35	2.50
74	SBP 36	80.45	317,220,963	1.35	2.50
75	SBP 66	78.55	388,947,383	1.34	2.22
76	SBP 68	81.85	324,665,373	1.35	2.50
77	SBP 69	83.75	369,168,303	1.34	2.50
78	SBP 71	77.30	374,113,073	1.34	2.22
79	SBP 79	73.30	346,076,763	1.35	2.22
80	SBP 80	68.05	346,076,763	1.35	2.00
81	SBP 84	81.55	326,839,563	1.35	2.50
82	SBP 85	81.40	339,763,263	1.35	2.50
83	SBP 96	77.50	360,504,663	1.35	2.22
84	SBP 97	75.70	346,076,763	1.35	2.22
85	SBP 100	75.30	317,220,963	1.35	2.22
86	SBP 102	81.25	322,030,263	1.35	2.50
87	SBP 110	77.45	326,839,563	1.35	2.22
88	SBE 34	67.60	279,052,693	1.35	2.00
89	SBE 35	81.85	352,951,463	1.35	2.50
90	SBP 89	73.70	339,515,323	1.35	2.22
91	SBP 80	73.20	440,286,373	1.30	2.22
92	SBE 29P	75.95	279,052,693	1.38	2.22
93	SBE 30	73.15	272,334,623	1.38	2.22
94	SBP 81	67.45	272,334,623	1.38	2.00
95	SBP 88	68.75	386,541,813	1.34	2.00
96	SBP 93	69.35	406,696,023	1.30	2.00
97	SBP 105	73.85	326,079,183	1.35	2.22
98	SBP 87	68.30	305,924,973	1.35	2.00
99	SBP 99	74.55	366,387,603	1.34	2.22
101	SBE 38	70.00	305,924,973	1.35	2.22
102	SBP 108	68.25	305,924,973	1.35	2.00
103	SBP 109	73.75	363,636,573	1.34	2.22
104	SBP 92	71.00	366,387,603	1.34	2.22
105	SBP 106	75.25	359,669,533	1.34	2.22
106	SBP 115	75.35	332,797,253	1.35	2.22
107	SBE 9P	81.05	352,287,913	1.34	2.50
108	SBE 19	79.10	391,846,073	1.33	2.22
109	SBE 32	79.35	337,453,603	1.35	2.22
110	SBP 14	79.35	401,885,113	1.30	2.22
111	SBP 70	81.65	299,941,523	1.35	2.50
112	SBP 77	80.75	334,554,913	1.35	2.50

5 Conclusions

The conclusions obtained from the analysis above are:

- 46 JIAT locations were not operating and the infrastructure was heavily damaged or totally gone (performance index was not asses or got zero).
- 20 JIAT locations usually were run, but the main infrastructure had been damaged during the research (performance index 55-69).

- 39 locations were run and the infrastructures were in a good condition/ slightly damaged (performance index 70-79).
- 6 JIAT locations just rehabilitated so the conditions were excellent (performance index > 79).
- The BCR value for the government is not always directly related with the performance index value, but is closely related to the AKNOP value. The bigger the AKNOP, the lower the BCR. However, of all JIAT locations that are still operating, all BCR numbers show results > 1, which means that JIAT development deserves to be continued economically.
- The BCR value for farmers is certainly not related to AKNOP, but is directly proportional to the performance index. The smaller the performance index, the smaller the BCR number. However, of all JIAT operating locations, all BCR figures show > 1 results, which means that the use of JIAT in 66 locations is worthy of being continued economically even though the fuel costs and other routine operations are borne by the farmers.

6 Recommendations

Suggestions that can be submitted from the results of this study are:

- The government should always carry out the obligation of maintenance according to the budget that has been prepared (AKNOP) so that JIAT's performance is always maintained.
- By seeing the benefits, in the future can be built more JIAT in locations that need it.
- For farmers, even though it is quite heavy to issue JIAT operating costs, but if seen in its entirety, farmers still benefit economically, so the self-management fee policy for JIAT operations should not be used as an excuse to ignore the infrastructure already built by the Government. This policy is also good enough to foster awareness of mutual cooperation and mutual ownership with Farmers.

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